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Western Spruce Budworm Damage Assessment Project: Wood-Core Analysis, Carson NF

The Record

The enclosed report discusses the status of the wood-core analysis phase of the Western Spruce Budworm Damage Assessment Project. It describes the problems encountered and outlines a proposed solution to them.

Since the report was written, I made a trip to the University of Arizona's Laboratory of Tree-Ring Research. I met with Dr. Marvin Stokes and his Modern Studies Staff Unit and we discussed the problems and proposed actions as stated in the report.

The final outcome of the discussions was a proposal from Dr. Stokes that the Laboratory do a complete wood-core analysis. They would collect the cores, date and measure them, check the dating and measurements, put the data through computer analysis, do climatic and insect correlations, and write a final report. The proposal from the Laboratory of Tree-Ring Research has been accepted. By May 15, 1982, the Laboratory will be sending us a detailed work plan. The cost to the Forest Service for the project will be $3,191.70 in F.Y. 1982 and $9,536.00 in F.Y. 1983. The Laboratory of Tree-Ring Research will contribute about $15,000 worth of staff time and facilities.

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Enclosure

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WESTERN SPRUCE BUDWORM DAMAGE ASSESSMENT PROJECT: WOOD-CORE ANALYSIS

1981 Progress Report

by

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I. INTRODUCTION

The western spruce budworm, Choristoneura occidentalis Freeman, is a major defoliator of Douglas-fir (Pseudotsuga menziesii) and true fir (Abies spp.) in the western United States. During outbreaks of this insect, repeated defoliation of host trees causes growth loss, top-kill, and tree mortality. In the Southwest, little information has been collected on these tree losses caused by the budworm; thus, a long-term damage assessment project was initiated in 1978. The purpose of the project is to assess damages to Douglas-fir, true fir, and spruce caused by the western spruce budworm on the Carson National Forest in northern New Mexico.[1/]

A major objective of the project is the evaluation of radial growth loss which resulted from past infestations that occurred from 1922-1966, and the current infestation which begain in 1975. Work on this objective began with the collection of increment cores in 1978 and 1979. However, major problems appeared when core data were prepared for statistical analysis. The problems were a result of errors in sampling technique and an inadequate knowledge of dendrochronology. The objectives of this report are to: (1) discuss some aspects of dendrochronology that are relevant to the project, (2) present the methods which have been used, (3) document the problems which resulted, and (4) recommend an appropriate course of action.

II. BACKGROUND INFORMATION

In this project, radial growth loss is being evaluated through the analysis of increment cores. Much of the work falls under the science of dendrochronology which is the study of "the chronological sequence of annual growth rings in trees" (Ferguson 1970). The basic technique of modern dendrochronology is cross-dating which allows the determination of tree-ring dates which are accurate to the year. Cross-dating is defined as the systematic comparison of tree-ring patterns: (1) between radii of a single tree, (2) between trees, (3) between species, (4) between age classes within a species, and (5) between sites and geographic areas in relation to one another and to climatic and historic data (Ferguson 1970).

Each annual growth ring of a tree is assigned to the calender year in which it was formed. Therefore, cores from living trees have a chronology control provided by the outermost ring with a precisely known date. Then each of the earlier formed growth rings are assigned sequentially earlier years. Trees are "sensitive" when they exhibit a

1/ For a detailed description of other aspects of the assessment project including sampling methodology such as budworm population estimates, defoliation, top-kill, and tree mortality, and a summary of 1978-1980 data, refer to "Western Spruce Budworm Damage Assessment Project, 1980, Progress Report No. 3" (Stein 1981).

large variation in diameter growth from year to year in response to a factor such as yearly changes in precipitation. Very sensitive trees will often have false and/or missing rings; however, these are identified during the cross-dating procedure (Ferguson 1970).

In a region with climatic stress, all sensitive trees should have the same pattern of wide and narrow rings that reflect the annual conditions in that region, and trees of the western United States are among the most climate-sensitive ones in the world (Anon. 1977). The master chronology (based on hundreds of trees from various sites) of a particular region is unique in its year to year pattern; never is the exact long-term sequence of rings repeated because climatic variation is never exactly the same (Ferguson 1970). On individual sites, trees can exhibit ring patterns which vary at times from the master chronology. This deviation from the regional pattern can be explained by factors, such as insect defoliation, which are not constant through time and which are variable over a region. It would therefore seem possible to determine the effects on tree growth of present and past occurrences of such factors by studying ring patterns. However, in the Southwest, budworm infestations may have occurred only in conjunction with periods of drought. If so, it will probably be impossible to separate the effects of the insect from that of weather.

III. METHODS

Core samples were taken from host trees in an attempt to measure radial growth loss and recovery for past infestations which occurred on the Carson National Forest from 1922 to 1966. Nonhost trees were sampled to determine expected growth of host trees and to help identify periods of growth loss due to other factors, such as drought. Increment cores were taken on blocks 1 throgh 12 in 1978 and on blocks 13 through 17 in 1979.

On each block, two increment cores, 90° apart, were taken at d.b.h. from each of 30 sample trees: 10 Douglas-fir, 10 true fir, and 10 ponderosa pine. The core samples were placed in plastic straws for storage and labeled with plot number, tree number, and species. Radial growth measurements were done on an Addo System by the Intermountain Forest and Range Experiment Station, Moscow, Idaho. The next step was to have been the determination of growth loss and recovery following each of the infestations. Also, analysis was to have been done to determine if differences in growth loss and recovery had occurred between the different site classes.

According to the project proposal, core samples would be taken during the final year of the project to determine when the current infestation began to affect radial growth and by what amount. Then estimated budworm populations would be related to tree defoliation and subsequent growth loss. Also, the samples would be analyzed to see if differences in growth reduction occurred between stands with different site classes and timber-size classes.

IV. DISCUSSION AND RECOMMENDATIONS

Problems appeared when the tree-ring measurements done on the Addo System were prepared for input to a tree-ring analysis computer program. Additional problems were found after consultation with George Ferrell, Pacific Northwest Forest and Range Experiment Station, who has worked on budworm associated growth loss in the Northwest, and with Marvin Stokes, who is with the University of Arizona's Laboratory of Tree-Ring Research. Major problems were:

A. Cores were stored in plastic straws. This situation favored the growth of wood-rotting fungi and resulted in the destruction of many of the cores.

B. On 1978 cores, measurements were made back only to 1939. The objective was to examine growth loss as early as the 1922 infestation. Also, in order to use routine computer programs for the statistical analysis of tree-ring series, it is important to have as long a series of measurements as possible; the entire core should have been measured.

C. On 1979 cores, all rings were measured; however, many cores were off-center or rotten due to improper storage. In addition, for almost every tree, the two cores contained a different number of rings. In some cases, this occurrence probably was due to improper storage. In addition, for almost every tree, the two cores contained a different number of rings. In some cases, this occurrence probably was due to the cores being off-center. However, it was impossible to verify this assumption because of the rotten and broken condition of most of the cores.

D. None of the cores were cross-dated. This should have been done prior to measuring the ring widths. Marvin Stokes examined several of the 1979 cores and found many which had one or more missing rings.

Based on several discussions with Marvin Stokes and George Ferrell, the following steps are proposed.

1. In the 1982 field season, increment cores will be taken from 10 Douglas-fir, 10 true fir, 10 spruce, and 10 ponderosa pine per block (when species is present). The cores will be stored in paper straws or wrapped individually in paper and stored in mailing tubes. Each core will be labeled with bock, tree number, species, and collection date. At a later date (preferably within a few weeks), the cores will be glued permanently on wood mounts and labeled (possibly this will be done by the Laboratory of Tree-Ring Research).

2. The cores will be ent to the University of Arizona Laboratory of Tree-Ring Research for cross-dating.

3. Each core will be read in its entirety by either the Laboratory of Tree-Ring Research or the Intermountain Forest and Range

Experiment Station. Obtaining a long series of measurements will enable computer analysis to fit the best growth curve to each tree. It will also provide more years of representative growth in which budworm was not present.

4. The computer package, developed by the Laboratory of Tree-Ring Research, will be used to analyze the measurements.

Tree growth during the current infestation will be examined first. The tree-ring patterns will be analyzed to determine when, in what way, and by how much, radial growth has been affected. Growth loss will be compared to insect density and defoliation data found on each block. The data will be analyzed to see if significant defferences in growth loss occurred between stands with different site classes and timber-size classes.

Past infestations will be analyzed using several tools: (1) the pattern of growth during current infestation, (2) weather records, (3) stand records, and (4) tree-ring chronologies which the Laboratory of Tree-Ring Research has obtained for several areas in northern New Mexico and southern Colorado. The general weather pattern for the area will be determined from the various sites. Then the weather will be factored out of the tree ring chronology of the assessment blocks. This step may make the budworm affected growth rings more visible.

By following the outlined procedure, a thorough growth-ring analysis will be obtained that should give the best information obtainable from regular wood cores. However, various factors, such as the conjunction of budworm infestations and drought, could make the wood core analysis useless for meeting the stated objectives. But, whatever the outcome, the study will have provided the knowledge of whether or not wood-core analysis is a useful tool for studying past budworm infestations in the Southwest.

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